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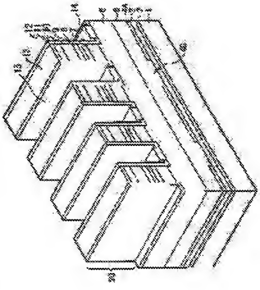
(54) SEMICONDUCTOR LASER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a multi-beam semiconductor light emitting device which is composed of group III-V nitride semiconductor layers and by which a high power can be attained with a simple structure.
SOLUTION: A buffer layer 2 and a seed crystal layer 3 are formed on a substrate 1 and bands of growth suppressing layer 4A and openings 4B are alternately provided at specified intervals on them. A GaN nitride semiconductor layer 5 is further grown on them from the openings 4B by a lateral growth technique. The nitride semiconductor layer 5 has low-defect parts including the lateral growth region and high-defect regions including through transpositions D1 and D2 which are generated on the top of the openings 4B and in assembled parts M. They are periodically formed according to the interval of the growth suppressing layer 4A. Light emitting parts 20 are periodically formed at specified intervals on the low-defect parts and (n) side electrodes 14 are formed in parts where the high-defect parts are removed. The light-emitting parts 20 are formed by etching with the mask of (p) side electrodes at one time.



CLAIMS

[Claim(s)]
[Claim 1]A semiconductor laser comprising:
consisting of a nitride system III-V fellows compound — a crystal part and alienation — a seed crystal section which has a part.
a low defect field formed based on said seed crystal section, and said alienation — a nitride semiconductor layer containing a meeting part formed in a field corresponding to a part.
Two or more light-emitting parts which have a current injection region respectively corresponding to a low defect field of said nitride semiconductor layer.

[Claim 2]The semiconductor laser according to claim 1, wherein said light-emitting part has a current injection

region corresponding to a field between said crystal part and said meeting part.
[Claim 3]The semiconductor laser according to claim 1, wherein said light-emitting part has a current injection region corresponding to a field between said meeting parts.
[Claim 4]The semiconductor laser according to claim 1, wherein an electrode of the 1st conduction type is provided on said light-emitting part and said light-emitting part and electrode of plane shape of said 1st conduction type correspond.
[Claim 5]The semiconductor laser according to claim 1 which an electrode of the 1st conduction type is provided on said light-emitting part, and is characterized by providing an electrode of the 2nd conduction type between said adjacent light-emitting parts.
[Claim 6]The semiconductor laser according to claim 5 having stood in a line at intervals of a cycle with same electrode of said 1st conduction type and electrode of said 2nd conduction type.
[Claim 7]The semiconductor laser according to claim 1, wherein said seed crystal section consists of GaN or $aluminum_xGa_{1-x}N$ (x is 0<=x<=1).

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the semiconductor laser which consists of a nitride system III-V fellows compound, and relates to the semiconductor laser which has two or more light-emitting parts especially.
[0002]
[Description of the Prior Art]the nitride system III-V fellows compound represented by GaN, an AlGaN mix crystal, or GaInN mix crystal -- the any -- although -- it is a transited [directly] type semiconductor. And in this system, since it crosses extensively with 1.9 eV - 6.2 eV at a room temperature and luminescence to the visible whole region is obtained from an ultraviolet area corresponding to this, the band gap attracts attention as a material of a semiconductor laser (Laser Diode;LD).
[0003]The light-emitting part is constituted by the nitride system group-III-V-semiconducter layer laminated by using vapor phase growth for this semiconductor laser on a substrate. The thing of different construction material from a nitride system III-V fellows compound is usually used for the substrate in that case.
The sapphire (alpha-aluminum $_2O_3$) board is mainly used.
However, sapphire and a nitride system III-V fellows compound have a large difference of a grating constant or a coefficient of thermal expansion, and in order to ease distortion by a substrate to a nitride system III-V fellows compound layer, lattice defects, such as a rearrangement, occur. Defect density became $10^{10} - 10^{11}cm^{-2}$, and a very high thing, and since the defective part became the nonluminescent center or current leakage part which does not emit light even if an electron and an electron hole recombine, it had actually become a factor which spoils the characteristic of an element.
[0004]As a method of reducing such a crystal defect, the art which forms a crystal layer with transverse direction growth attracts attention in recent years. As the example, the mask which has an opening is formed on the nitride semiconductor layer used as a ground, and the method of growing up a nitride semiconductor on the basis of the nitride semiconductor layer expressed from an opening is mentioned. If a growing condition is chosen in that case, in the way of the transverse direction growth which grows horizontally along with a mask from an opening, compared with the lengthwise direction growth which grows up to be the upper part from an opening, speed will become quick, and a crystal will mainly grow up to be a transverse direction. And the crystals

which carried out transverse direction growth meet eventually, and one layer is formed. Thus, in the formed layer, although it spreads so that the rearrangement from the layer used as the foundation may penetrate the inside of a layer, since a rearrangement is also crooked in a transverse direction in a transverse direction growing region, it is rare [it] in the field and meeting part which hit right above an opening, to spread to the upper levels. Therefore, the rearrangement spread to the nitride semiconductor layer grown up on it decreases, and the semiconductor layer of a low defect can be laminated as a whole.

[0005]In addition -- providing the convex crystal part which consists of a nitride system III-V fellows compound on silicon on sapphire, and being based on a crystal part -- alienation in the meantime -- the art of growing up a crystal into a part is proposed. A growing condition is set up also in this case, and the same transverse direction growing region as the above-mentioned method is formed by making it grow up in the direction which is different from a laminating direction from the side side of a crystal part. [transverse direction growth]

[0006]In this way, it is also possible to make even 10^{4} - $10^{6}cm^{-2}$ reduce the defect density of a transverse direction growing region, and to suppose no transposing near [the] the upper surface substantially in the nitride semiconductor layer formed. then, although to raise the characteristic of a light emitting device using the good nitride system III-V fellows compound crystal obtained by such art was desired, even if it was such a case, the penetration dislocation produced to fields other than a transverse direction growing region had caused degradation of the element characteristic.

[0007]It is thought that the problem originating in the above defects is reduced by replacing with silicon on sapphire etc. and using nitride system III-V fellows compound boards, such as GaN, recent years come, and examination is progressing. The substrate which consists of a nitride system III-V fellows compound is manufactured by dissociating from the base for growth, after making it grow up on the base for growth which consists of sapphire etc. for example. If this nitride system III-V fellows compound board is used, an above-mentioned problem is solvable, and the thermal conductivity outstanding as compared with silicon on sapphire can be obtained, and there is an advantage that heat can be efficiently radiated at the time of an element drive. It becomes possible to provide an electrode in the rear face of a substrate by adding an impurity and giving conductivity, and has an advantage of element size being reduced. . However, defect density is below a $10^{6}cm^{-2}$ stand. When the nitride system III-V fellows compound board with sufficiently good crystallinity is not yet developed but it uses this kind of substrate, it is necessary to reduce a crystal defect using mist beam transverse direction growth art.

[0008]In order to make the crystallinity of a substrate face uniform, in such art, the seed crystal and mask which are provided usually have several micrometer a unit of periodical structure, and the rearrangement is also periodically produced in connection with it. Therefore, it is possible to choose a field with few rearrangements on the upper surface of a substrate, and light emitting devices (stripe portion which includes a luminous region strictly), such as a semiconductor laser, were able to be formed on such a low defect field.

[0009]

[Problem(s) to be Solved by the Invention]However, when designing a light-emitting part for a wide stripe about 10 micrometers in stripe width for a high increase in power in producing high-output laser, the parenchyma top was difficult for avoiding thoroughly the penetration dislocation which exists in the opening of a mask, or the upper part of a crystal part, and forming a light-emitting part. Therefore, it was difficult to bring degradation of the element characteristic by the nonluminescent recombination resulting from a rearrangement, etc., and a result which especially causes the fall of a radiant power output, and to obtain not less than 100-mW high power with wide stripe laser.

[0010]Although the multi-beam laser which fixed two or more light-emitting parts on one substrate has been conventionally developed by the printer use etc., The nitride system III-V fellows compound which otherwise towers and has the outstanding feature (it is difficult to obtain a good crystal on the other hand) is not almost used for multi-beam laser. High output laser which is multi-beam laser of a nitride system III-V fellows compound, for example, is not less than 100 mW was not obtained.

[0011]This invention was made in view of this problem, and the purpose is to provide the semiconductor laser of the multi-beam which consists of a nitride system III-V fellows compound which can attain high power with simple composition.

[0012]

[Means for Solving the Problem]A semiconductor laser by this invention is provided with the following.

consisting of a nitride system III-V fellows compound -- a crystal part and alienation -- a seed crystal section which has a part.

a low defect field formed based on this seed crystal section, and alienation of a seed crystal section -- a nitride semiconductor layer containing a meeting part formed in a field corresponding to a part.

Two or more light-emitting parts which have a current injection region respectively corresponding to a low defect field of said nitride semiconductor layer.

[0013]In a semiconductor laser by this invention, since all the light-emitting parts are formed in the upper part of a low defect field of a nitride semiconductor layer, each light-emitting part avoids influence of a defect, and emits light by an original radiant power output of material.
[0014]
[Embodiment of the Invention]Hereafter, an embodiment of the invention is described in detail with reference to drawings.
[0015][A 1st embodiment] Drawing 1 expresses the composition of the semiconductor laser concerning a 1st embodiment of this invention, and drawing 2 is the elements on larger scale of drawing 1. This semiconductor laser is having structure where two or more light-emitting parts 20 were formed on the nitride semiconductor layer 5. Here, the substrate 1 consists of sapphire, for example, and the buffer layer 2 is formed on the c side. The buffer layer 2 serves as a core at the time of growing up the seed crystal layer 3, and consists of undope-GaN which does not add the impurity whose thickness is 0.01 micrometer - 2.0 micrometers.
[0016]The seed crystal layer 3 consists of a nitride system III-V fellows compound. With a nitride system III-V fellows compound here. They are at least one sort in group-III-elements groups, such as gallium (Ga), aluminum (aluminum), boron (B), or indium (In), and a thing of the V group elements which contains nitrogen (N) at least. It specifically consisted of 2-micrometer-thick undope-GaN, and the penetration dislocation prolonged in a laminating direction as the small-gage wire showed to drawing 2 has produced 10^{8} - $10^{9}cm^{-2}$. On the seed crystal layer 3, two or more growth deterrence layers 4A prolonged in band-like are formed, and between the growth deterrence layers 4A which adjoin mutually serves as the opening 4B. The thickness of this growth deterrence layer 4A is 300 micrometers, and each width of the growth deterrence layer 4A and the opening 4B can be 8 micrometers and 4 micrometers, for example. Here, the growth deterrence layer 4A and the opening 4B are periodically formed at the predetermined intervals to the cross direction. The growth deterrence layer 4A, for example Dielectric materials, such as silica dioxide (SiO_2), silicon nitride (Si_3N_4), and aluminum oxide ($aluminum_2O_3$). Or it is constituted by refractory metals, such as tungsten (W) molybdenum (Mo). in addition -- the seed crystal layer 3 expressed from the opening 4B corresponds to the "crystal part" of this invention here -- the growth deterrence layer 4A and its upper field -- this invention -- "-- alienation -- part" is supported.
[0017]On it, the nitride semiconductor layer 5 is formed by making it grow up on the growth deterrence layer 4A on the basis of the seed crystal layer 3 expressed from the opening 4B. The nitride semiconductor layer 5 is also constituted by undope-GaN whose nitride system III-V fellows compound, for example, thickness, is 10 micrometers, and like drawing 2, It grows up to be lengthwise direction (layer thickness direction) L_1 and transverse direction (parallel to stratification plane) L_2 from the opening 4B on the basis of the seed crystal layer 3. The meeting part M in which the crystals which carried out transverse direction growth from the adjacent opening 4B meet exists near a right above [the growth deterrence layer 4A] center exactly among this nitride semiconductor layer 5. Penetration dislocation D_1 to which the penetration dislocation of the seed crystal layer 3 reaches even the upper levels further about the rearrangement to which propagation was prevented by the growth deterrence layer 4A, and it was spread from the opening 4B to the nitride semiconductor layer 5, and the thing which curves to a growth direction (transverse direction L_2) exist.
[0018]Therefore, the main rearrangements which get across to the upper surface of the nitride semiconductor layer 5 are penetration dislocation D_1 spread in the upper part of the opening 4B, and penetration dislocation D_2 in alignment with the meeting part M. These penetration dislocation D_1 and D_2 are produced here the same cycle as the growth deterrence layer 4A and the opening 4B. In the portion except [these] including a transverse direction growing region, dislocation density is 10^{4} - a $10^{5}cm^{-2}$ grade.
[0019]On the nitride semiconductor layer 5, the n side contact layer 6, the n type clad layer 7, the 1st guide layer 8, the active layer 9, the 2nd guide layer 10, the p type clad layer 11, and the p side contact layer 12 are laminated one by one, and the light-emitting part 20 is constituted. The light-emitting part 20 avoids the circumference of penetration dislocation D_1 of the nitride semiconductor layer 5, and D_2, is formed in the upper surface of a low defect field including the transverse direction growing region, and here, According to the cycle of the growth deterrence layer 4A and the opening 4B (jams are penetration dislocation D_1 and D_2), it has stood in a line periodically.
[0020]Thickness is 4 micrometers and the n side contact layer 6 is constituted by n type GaN which added n

type impurities, such as silicon (Si), for example. Thickness is 0.8 micrometer and the n type clad layer 7 is constituted by the n type AlGaN mix crystal which added n type impurities, such as silicon (Si), for example. The 1st guide layer 8 is constituted by 0.1-micrometer-thick n type GaN, for example.

[0021]The active layer 9 is constituted by the undope-GaInN mix crystal which does not add an impurity, for example, and the thickness of a well has 3 nm and multiple quantum well structure whose thickness of a barrier layer is 10 nm. Here, the whole active layer 9 serves as a current injection region, and emits light by pouring of current.

[0022]Thickness is 0.1 micrometer and the 2nd guide layer 10 is constituted by p type GaN which added p type impurities, such as magnesium (Mg), for example. Thickness is 0.5 micrometer and the p type clad layer 11 is constituted by the p type AlGaN mix crystal which added p type impurities, such as magnesium (Mg), for example. The p side contact layer 12 is constituted by 0.1-micrometer-thick p type GaN, for example.

[0023]Right above the p side contact layer 12, the p lateral electrode 13 is formed in the whole surface on the light-emitting part 20. It is electrically connected with the p side contact layer 12, and that plane shape of this p lateral electrode 13 corresponds with the light-emitting part 20. Such a p lateral electrode 13 has the structure where palladium (Pd), platinum (Pt), and gold (Au) were laminated one by one from the p side contact layer 12 side, for example. As a material of the p lateral electrode 13, in addition, nickel (nickel), It is also possible to use combining at least two from the inside of the above material that tungsten (W), titanium (Ti), etc. were mentioned and was combined with the above-mentioned palladium (Pd), such as nickel/Pt and Pd/Pt, and platinum (Pt).

[0024]On the other hand, between the adjacent light-emitting parts 20, the band-like n lateral electrode 14 is formed on the n side contact layer 6, for example. The n lateral electrode 14 has the structure where titanium (Ti) and aluminum (aluminum) were laminated sequentially from the n side contact layer 6 side, or a laminated structure of Ti/Pt/Au, for example, and is electrically connected with the n side contact layer 6. Here, this n lateral electrode 14 as well as the light-emitting part 20 or the p lateral electrode 13 is periodically formed to the cross direction.

[0025]From the opposed face of the adjacent light-emitting part 20, i.e., the side of the light-emitting part 20, it applies to the field to which the n lateral electrode 14 on the n side contact layer 6 is not attached, and is covered with the insulating layer 15. As the insulating layer 15, insulator layers, such as silica dioxide (SiO_2), silicon nitride (SiN), diacid-ized zirconium (ZrO_2), and 4 zirconium oxide (ZrO_4), can be used, for example.

[0026]The semiconductor laser of such composition can be manufactured as follows. A part of one semiconductor laser is shown in each process drawing referred to below as a representative.

[0027]First, as shown in drawing 3 (A), it has two or more semiconductor laser formation areas, and the substrate 1 with a thickness of 400 micrometers which consists of sapphire, for example is prepared, and the buffer layer 2 which consists of undope-GaN is formed in c side of the substrate 1 by the MOCVD method. In that case, temperature of the substrate 1 is made low with 520 **, and grows up a near crystal layer amorphously, for example. Trimethylgallium (CH_3) ($_3$ Ga) and ammonia (NH_3) are used for a raw material.

[0028]Next, the seed crystal layer 3 which consists of undope-GaN in a similar manner, for example by the MOCVD method is formed on the buffer layer 2. However, rather than the case where the buffer layer 2 is grown up, the temperature of the substrate 1 shall be hot 1020 **, and grows up a crystal layer. As the small-gage wire showed drawing 2, high-density penetration dislocation exists in this seed crystal layer 3.

[0029]Then, as shown in drawing 3 (B), two or more openings 4B and growth deterrence layers 4A which were extended by band-like are formed on the seed crystal layer 3, respectively. Here, these are provided at the predetermined intervals to the cross direction. First, the temperature of the substrate 1 shall be 300 ** for example, by the CVD (Chemical Vapor Deposition) method, and a silicon dioxide layer is specifically formed. Spreading formation of the resist film which is not illustrated on it is carried out, and two or more parallel band-like mask patterns are formed by a photolithography, and also it etches by making this into a mask, and a silicon dioxide layer is removed. The left-behind silicon dioxide layer is the growth deterrence layer 4A, and the other removal section is equivalent to the opening 4B.

[0030]Next, as shown in drawing 3 (C), the nitride semiconductor layer 5 which comes from undope-GaN, for example by the MOCVD method on the growth deterrence layer 4 is grown up. At this time, selective growth that the section of that cross direction serves as a triangle in each opening 4B is performed in the beginning. In these crystalline regions, the penetration dislocation from the seed crystal layer 3 has spread. If growth progresses, a crosswise section will serve as trapezoidal shape and a crystal [in / since speed is quicker than lengthwise direction growth / in the direction of transverse direction growth / each opening 4B] will cover the upper part of the mask part 4A of both the sides gradually with transverse direction growth. Since penetration dislocation is not spread in a transverse direction, penetration dislocation hardly exists in the upper part of the mask part 4A. Simultaneously, although the rearrangement which has passed the opening 4B has penetration

dislocation D_1 spread in the upper levels as it is, it is crooked in a transverse direction. And the crystal which grew up to be a transverse direction from the adjacent opening 4B finally meets near a right above [the mask part 4A] center, and the meeting part M is formed, and the rearrangement convergent toward this meeting part M serves as penetration dislocation D_2 which pierces through the nitride semiconductor layer 5. Thus, if the crystal which met is fully grown up, the upper part will serve as a flat face and the nitride semiconductor layer 5 will be formed as one layer (refer to drawing 2).

[0031]Therefore, in the nitride semiconductor layer 5, penetration dislocation D_1 and D_2 which reach the upper part of each opening 4B and each meeting part M even at the layer upper surface arise periodically, and. The field which hits the upper part of mask parts 4A other than these, i.e., a transverse direction growing region, turns into a low defect field with few rearrangements where defect density is very low.

[0032]Next, as shown in drawing 4, on the nitride semiconductor layer 5 for example, The n side contact layer 6 which consists of n type GaN, the n type clad layer 7 which consists of n type AlGaN, the 1st guide layer 8 that consists of n type GaN, the active layer 9 which consists of undope-GaInN, the 2nd guide layer 10 that consists of p type GaN, the p type clad layer 11 which consists of p type AlGaN. And the p side contact layer 12 which consists of p type GaN is grown up one by one for example, using the MOCVD method.

[0033]In that case, the temperature of the substrate 1 shall be 800-1000 **, for example, As a raw material of aluminum, trimethylaluminum (CH_3) ($_3$aluminum), As a raw material of gallium, ammonia gas is used as material gas of trimethylindium (CH_3) ($_3$ In) and nitrogen as a raw material of trimethylgallium and indium, respectively. In adding silicon as a n type impurity. In adding magnesium as a p type impurity, using monosilane gas (SiH_4) as material gas of silicon. Screw = methylcyclopentadienyl magnesium ($CH_3C_5H_4$) ($_2$Mg) or screw = magnesium cyclopentadienyl (C_5H_5) ($_2$Mg) is used as a raw material of magnesium, respectively.

[0034]Thereby, penetration dislocation D_2 from penetration dislocation D_1 and the meeting part M from the opening 4B spreads, and while the part serves as a high defect region formed periodically, good crystallinity is acquired by each class of the n side contact layer 6 - the p side contact layer 12 by the other part.

[0035]Next, as shown in drawing 5, two or more p lateral electrodes 13 extended by band-like are formed on the p side contact layer 12 at a position using photolithography technique and etching technology. The p lateral electrode 13 functions also as a mask in the case of the stripe formation explained below, and here, The high defect region where the p lateral electrodes 13 each hit the upper part of the opening 4B in the nitride semiconductor layer 5 and the meeting part M is avoided, and it is periodically provided at the predetermined intervals so that it may be located in the upper part of the field which is a low defect comparatively in the nitride semiconductor layer 5.

[0036]Next, as shown in drawing 6, dry etching, such as RIE (Reactive Ion Etching: reactive ion etching), is performed by using this p lateral electrode 13 as a mask, for example, The p side contact layer 12, the p type clad layer 11, the 2nd guide layer 10, the active layer 9, the 1st guide layer 8, and the n type clad layer 7 are removed selectively one by one, and the n side contact layer 6 is exposed. Thereby, the light-emitting part 20 of the stripe shape whose plane shape corresponds with p lateral electrode is periodically formed at the predetermined intervals. Therefore, this light-emitting part 20 is formed in a low defect field as well as the p lateral electrode 13, and the portion by which etching removal is carried out at this time serves as a high defect region which hits the upper part of the opening 4B and the meeting part M conversely.

[0037]Next, as shown in drawing 7, the insulating layer 15 which consists of silica dioxides, for example with vacuum deposition is formed on the both side surfaces of each light-emitting part 20, and the n exposed side contact layers 6 each. An opening is provided in the insulating layer 15 on the n side contact layer 6, and two or more n lateral electrodes 14 extended by band-like there are periodically formed at the predetermined intervals. The opening of the prescribed position of the insulating layer 15 is carried out, for example, sequent deposition of titanium (Ti), aluminum (aluminum), and the gold (Au) is carried out with a vacuum deposition method, and, specifically, it forms.

[0038]After it, the substrate 1 is ground so that it may become a thickness of about 80 micrometers. Cleavage of the substrate 1 is vertically carried out to the length direction of the p lateral electrode 13 by predetermined width, and the reflector film which is not illustrated to the cleavage plane is formed.

[0039]In the semiconductor laser which has such two or more light-emitting parts 20, in order to prevent the faulty connection of the electrode and lead which were provided in each light-emitting part upper part generally, a semiconductor laser is fixed on the wiring board by which wiring was provided in each electrodes. For example, according to the art indicated by JP,5-335685,A, the electrode 113 by the side of the upper part of a light-emitting part and the electrode 114 by the side of the fundus of a light-emitting part are connected to the

electrode wiring 101 on the wiring board 100 like drawing 17. The electrode 114 by the side of the fundus of a light-emitting part is formed in a total of two places of the both ends of two or more light-emitting parts, and two electrodes flow through it with all the light-emitting parts. Also in this embodiment, it is possible to wire by installing a semiconductor laser like drawing 1 on a substrate like the wiring board 100, using the n lateral electrode 14 as a common electrode of each light-emitting part 20.

[0040]However, he is trying to form the n lateral electrode 14 one [at a time] to each light-emitting part 20 here. If the n lateral electrode 14 is used as a common electrode, it will be because the distance of the p lateral electrode 13 and common electrode in each light-emitting part will differ, respectively, inter-electrode voltage or resistance increases in the further light-emitting part from an electrode and the operating characteristic of an element is affected. Therefore, it is more desirable to provide electrode wiring in a wiring board also to the n lateral electrode 14 at each.

[0041]In this semiconductor laser, if predetermined voltage is impressed between the p lateral electrode 13 and the n lateral electrode 14, current will be poured into the active layer 9 and luminescence will take place by electronic-electron hole recombination. Here, since the plane shape of the p lateral electrode 13 and the light-emitting part 20 is in agreement, all of the active layers 9 serve as a current injection region where current is poured in from the p lateral electrode 13. Since the light-emitting part 20 is formed in the low defect field of the nitride semiconductor layer 5, degradation by a laser beam being absorbed by the defective part does not take place easily, increase of the actuating current under drive is suppressed, the life of an element becomes long and its radiant power output improves.

[0042]Thus, according to the semiconductor laser concerning this embodiment, the growth deterrence layer 4A which has the opening 4B is formed on the seed crystal layer 3, Since the nitride semiconductor layer 5 is formed with transverse direction growth on the basis of the seed crystal layer 3 expressed from the opening 4B and the light-emitting part 20 was moreover formed on the rearrangement in the nitride semiconductor layer 5, and the low defect field with few defects, The density of penetration dislocation is low also about each class of light-emitting part 20 inside, and it has become a low defect. Simultaneously, many penetration dislocation D_1 and D_2 exist and the opening 4B and near meeting part M are deleted by formation of the light-emitting part 20. [used as a high defect region] Therefore, the rate of the nonluminescent recombination resulting from penetration dislocation etc. can be made small, luminous efficiency can be raised, and an output can be increased. Degradation resulting from a defect does not take place easily, and each nitride semiconductor layer of the light-emitting part 20 represented by the active layer 9 can attain reinforcement.

[0043]By giving periodicity to the interval of the growth deterrence layer 4A and the opening 4B in this embodiment, The position of penetration dislocation D_1 produced in the nitride semiconductor layer 5 and D_2 is controlled, and since the light-emitting part 20 was formed at intervals of the cycle decided beforehand, two or more light-emitting parts 20 can be formed with sufficient accuracy on the field of a request of the nitride semiconductor layer 5 by a simple method at once.

[0044]Since the p lateral electrode 13 was directly formed right above the p side contact layer 12, contact resistance can be reduced. Since the stripe of the light-emitting part 20 was formed by using the p lateral electrode 13 as a mask, such a semiconductor laser can be made into a simple structure, and it can manufacture by a simple method.

[0045]Since a common electrode is not provided but the n lateral electrode 14 was formed to each light-emitting part 20, all the light-emitting parts 20 can be operated simultaneously, and the desired characteristic can be obtained from each of the light-emitting part 20.

[0046][A 2nd embodiment] Drawing 8 expresses the composition of the semiconductor laser concerning a 2nd embodiment, and drawing 9 is the elements on larger scale of drawing 8. This semiconductor laser is the same as that of a 1st embodiment except for that the nitride semiconductor layer 35 grows from the seed crystal section 33 provided on the substrate 31, and this nitride semiconductor layer 35 functioning as an n side contact layer. Therefore, the same numerals are given to the same component as a 1st embodiment, and the explanation is omitted.

[0047]The substrate 31 has the crevice 31B dug deep by etching etc. at the predetermined intervals by the upper surface which consists of sapphire, for example and consists of the c side. between the crystal parts 33A which the crystal part 33A is formed, for example in stripe shape, and adjoin the upper surfaces other than crevice 31B of the substrate 31 -- alienation -- it is the part 33B.

[0048]The crystal part 33A serves as a core at the time of growing up the nitride semiconductor layer 35, and consists of undope-GaN which does not add a 2-micrometer-thick impurity. these crystal parts 33A and alienation -- each width of the part 33B is 2 micrometers - 4 micrometers, and 10 micrometers - 20 micrometers, for example, and these are provided periodically by turns here. As a small-gage wire shows to

drawing 9, in the crystal part 33A, penetration dislocation D_1 prolonged in a laminating direction has arisen, and the dislocation density is dramatically high to it.
[0049]The nitride semiconductor layer 35 is formed on it. The nitride semiconductor layer 35 is constituted by n type GaN which added silicon (Si) as a 4-micrometer-thick n type impurity, for example. The nitride semiconductor layer 35 grows up to be lengthwise direction (layer thickness direction) L_1 and transverse direction (parallel to stratification plane) L_2 on the basis of the crystal part 33A like drawing 9, alienation -- the meeting part M whose crystals which carried out transverse direction growth from the crystal part 33A of the part 33B which adjoins each other near a center exactly meet exists. Here, the rearrangement is prevented from the nitride semiconductor layer 35 producing a crevice between the substrates 31 by the crevice 31B, and both contacting and arising in the nitride semiconductor layer 35. Although penetration dislocation D_1 of the crystal part 33A is spread in a lengthwise direction growing region on top at this time, it does not get across to a transverse direction growing region. On the other hand, in a transverse direction growing region, penetration dislocation D_2 arises along with the meeting part M. Therefore, in the nitride semiconductor layer 35, the main rearrangements spread even on the upper surface are these penetration dislocation D_1 and D_2, and fields other than these peripheries. The density of a rearrangement is as low as 10^4 - a $10^6 cm^{-2}$ grade, and the defect serves as few low defect fields. in addition -- here -- penetration dislocation D_1 and D_2 -- again -- the crystal part 33A and alienation -- it is generating the same cycle as the part 33B.
[0050]On such a nitride semiconductor layer 35, the n side contact layer 6, the n type clad layer 7, the 1st guide layer 8, the active layer 9, the 2nd guide layer 10, the p type clad layer 11, and the p side contact layer 12 are laminated one by one like a 1st embodiment, and the light-emitting part 20 is constituted. Between the adjacent light-emitting parts 20, the n lateral electrode 14 is formed on the n side contact layer 6, it applies to the field to which the n lateral electrode 14 on the n side contact layer 6 is not further attached from the opposed face of the adjacent light-emitting part 20, and the insulating layer 15 is formed.
[0051]Next, the manufacturing method of such a semiconductor laser is explained, referring to drawing 8, drawing 9 and drawing 10 - drawing 15.
[0052]First, the substrate 31 with a thickness of 400 micrometers which it has two or more semiconductor laser formation areas as shown in drawing 10 (A), and consists of sapphire is prepared. The growth phase 33a for seed crystal layers for forming the seed crystal section 33 (refer to drawing 11) which grows up into a thickness of about 2 micrometers the crystal of undope-GaN which does not add an impurity, for example by the MOCVD method, and mentions it later on c side of the substrate 31 is formed. Although MOCVD can be carried out into which [in a normal pressure atmosphere, a decompressed atmosphere, or application-of-pressure atmosphere] atmosphere, in order to obtain a good crystal, it is preferred to carry out into application-of-pressure atmosphere.
[0053]Subsequently, as shown in drawing 10 (B), the insulator layer 34 which consists of silica dioxides (SiO_2) with a CVD method is formed. This insulator layer 34 can also be formed by silicon nitride (Si_3N_4) etc., and is good also as a laminated structure of a silicon nitride film and a silica dioxide film.
[0054]As shown in drawing 10 (C) after it, the specified shape which removes the insulator layer 34 selectively, for example, is extended by band-like is formed selectively. A photoresist film is removed, after it forms the photoresist film of stripe shape on the insulator layer 34 first and RIE removes [for example,] the insulator layer 34 selectively by specifically using this photoresist film as a mask further.
[0055]Next, as shown in drawing 11 (A), RIE which made gaseous chlorine (Cl_2) etching gas, for example is performed by using the insulator layer 34 as a mask, and the portion which is not covered with the insulator layer 34 of the growth phase 33a for seed crystal layers is removed. thereby -- the growth phase 33a for seed crystal layers -- a predetermined interval -- the crystal part 33A and alienation -- the part 33B turns into the seed crystal section 33 located in a line by turns.
[0056]Then, RIE is performed by using the insulator layer 34 as a mask, for example, the portion which is not covered with the insulator layer 34 of the substrate 31 is removed further. Gaseous chlorine is used for etching gas and, specifically, it carries out on with the substrate temperature of 0 **, and a pressure of 0.5 Pa conditions, for example. thereby -- the upper surface of the substrate 31 -- the crevice 31B -- alienation -- it is formed so that the part 33B may be followed. It may carry out continuously with etching of the growth phase 33a for seed crystal layers, and the etching process over this substrate 31 can also be carried out as a separated process.
[0057]As for the depth of this crevice 31B, it is preferred that it is not less than 100 nm. The transverse direction growth from the crystal part 33A advances to the substrate 31 side not just beside but a little, and the

nitride semiconductor layer 35 (refer to drawing 12) mentioned later may contact the substrate 31. When the crevice 31B is not formed, the nitride semiconductor layer 35 grows so that the substrate 31 may be contacted, but the crystals which carried out transverse direction growth in that case do not meet, but there is a possibility that a flat field may not be acquired substantially. It is because it is necessary to fully take the depth of the crevice 31B in order to avoid the above and to prevent effectively contact with the nitride semiconductor layer 35 and the substrate 31.

[0058]Next, as shown in drawing 11 (B), etching using the solution which contains hydrogen fluoride (HF) as an etching agent is performed, and the insulator layer 13 is removed.

[0059]Next, as shown in drawing 12, the nitride semiconductor layer 35 is formed by growing up about 4 micrometers of crystals of n type GaN which added silicon (Si) as a n type impurity using the MOCVD method. this time -- the crystal growth of GaN -- the upper surface of the crystal part 33A, and alienation -- it goes on from the wall surface facing the part 33B to lengthwise direction (layer thickness direction) L_1 and transverse direction (parallel to stratification plane) L_2, respectively (drawing 9). In that case, penetration dislocation D_1 which the crystal part 33A has spreads by lengthwise direction L_1. On the other hand, in transverse direction L_2, penetration dislocation D_1 is crooked in a transverse direction, and hardly exists. therefore, alienation -- the transverse direction growing region formed in the field which hits the part 33B has the low density of penetration dislocation, and turns into a low defect field.

[0060]The speed of transverse direction growth here of a crystal is set up more quickly than the speed of lengthwise direction growth. therefore, alienation -- the field which hits the part 33B being covered as the crystal which grows on the basis of each crystal part 33A, and finally, adjacent crystals -- alienation -- the rearrangement of the part 33B which met near the center mostly, and the meeting part M was formed, and was converged toward this meeting part M serves as penetration dislocation D_2 which pierces through the nitride semiconductor layer 35. Thus, if the crystal which met is fully grown up, the upper part will serve as a flat face and the nitride semiconductor layer 35 will be formed as one layer. According to this embodiment, since the crevice 31B is established in the substrate 31, a defect is prevented from the crystal which grew up to be a transverse direction contacting the substrate 31, and occurring as already stated. penetration dislocation D_1 and D_2 -- consequential -- the crystal part 33A and alienation -- it is formed so that it may have the same cycle as the part 33B.

[0061]Next, as shown in drawing 13, it is made to be the same as that of a 1st embodiment on the nitride semiconductor layer 35, The n type clad layer 7, the 1st guide layer 8, the active layer 9, the 2nd guide layer 10, the p type clad layer 11, and the p side contact layer 12 are grown up one by one, and the p lateral electrode 13 is formed in the position on the p side contact layer 12. The upper part of penetration dislocation D_2 produced in penetration dislocation D_1 and the meeting part M which the p lateral electrode 13 is stripe shape, for example, and are produced on the crystal part 33A in the nitride semiconductor layer 35 at this time is avoided, It is periodically formed at the predetermined intervals so that it may be located in the upper part of the low defect field of the nitride semiconductor layer 35.

[0062]After that, as shown in drawing 14, the p lateral electrode 13 by the dry etching used as the mask like a 1st embodiment. The p side contact layer 12, the p type clad layer 11, the 2nd guide layer 10, the active layer 9, the 1st guide layer 8, and the n type clad layer 7 are removed selectively one by one, and the nitride semiconductor layer 35 is exposed. Thereby, two or more light-emitting parts 20 of the plane shape which is in agreement with the p lateral electrode 13 are formed. Therefore, in this light-emitting part 20, the whole surface of the active layer 9 serves as a current injection region where current is poured in from the p lateral electrode 13. Since the light-emitting part 20 is periodically formed in a low defect field at the predetermined intervals like the p lateral electrode 13, the portion by which etching removal is carried out serves as a high defect region which hits the upper part of penetration dislocation D_1 in the nitride semiconductor layer 35, and D_2.

[0063]Then, as shown in drawing 15, the insulating layer 15 is formed by the same method as a 1st embodiment on the both side surfaces of the light-emitting part 20, and the exposed nitride semiconductor layer 35, and two or more n lateral electrodes 14 extended by band-like are formed at the predetermined intervals on the nitride semiconductor layer 35.

[0064]After it, the substrate 31 is ground so that it may become a thickness of about 80 micrometers. Cleavage of the substrate 31 is vertically carried out to the length direction of the p lateral electrode 13 by predetermined width, and the reflector film which is not illustrated to the cleavage plane is formed.

[0065]Electrode wiring can be given on a wiring board so that the p lateral electrode 13 and the n lateral electrode 14 may be independently wired every light-emitting part 20 like [the semiconductor laser produced by

doing in this way] a 1st embodiment. About the n lateral electrode 14, it is also possible to provide a common electrode like drawing 16.

[0066]In this semiconductor laser, penetration dislocation D_1 and D_2 exist in the upper part of the crystal part 33A, and the meeting part M periodically among the nitride semiconductor layers 35, and the other field is a low defect field with few defects where the density of penetration dislocation is low. The light-emitting part 20 is periodically formed in this low defect field at the predetermined intervals, and near the upper part of the high crystal part 33A of defect density and near meeting part M are simultaneously deleted at the time of formation of the light-emitting part 20. Therefore, in the current injection region of the light-emitting part 20, the rate of nonluminescent recombination decreases, luminous efficiency improves, and the output of an element increases. Degradation by impression of voltage does not take place easily, and the life of an element becomes long.

[0067]Thus, also in the semiconductor laser concerning this embodiment, the same effect as a 1st embodiment can be acquired.

[0068][A 3rd embodiment] Drawing 16 expresses the composition of the semiconductor laser concerning a 3rd embodiment. This semiconductor laser is having structure which the lower layer portion of the nitride semiconductor layer 5 is removed with the growth deterrence layer 4A in the semiconductor laser concerning a 1st embodiment, and makes the nitride semiconductor layer 5 a contact layer. Although the n lateral electrode 14 is formed on the contact layer 6 in the above-mentioned embodiment, the n lateral electrode 44 is formed in the rear face of the nitride semiconductor layer 45 in this embodiment. The same numerals are given to the same component as a 1st embodiment other than this, and explanation is omitted here.

[0069]The nitride semiconductor layer 45 is a semiconductor layer which consists of a nitride system III-V fellows compound who made it grow up by the same method as the nitride semiconductor layer 5. Therefore, also when manufacturing this semiconductor laser, the buffer layer 2 and the seed crystal layer 3 are first grown up on the substrate 1 in the way explained to a 1st embodiment, the growth deterrence layer 4A which has the opening 4B is formed, and the nitride semiconductor layer 5 is grown up into sufficient thickness on it. Then, the nitride semiconductor layer 45 is obtained by separating the nitride semiconductor layer 5 from the substrate 31 in the lower layer portion containing the growth deterrence layer 4A.

[0070]Also in this nitride semiconductor layer 45, penetration dislocation D_1 and D_2 which reach the opening 4B and the meeting part M even at the layer upper surface have arisen periodically, and the other field having included the transverse direction growing region is a low defect field with few rearrangements and defects. Then, the light-emitting part 20 is formed on this low defect field. The light-emitting part 20 can be formed by using the p lateral electrode 13 as a mask also here again. However, about the n lateral electrode 44, it is formed all over the back side of the nitride semiconductor layer 45 as a common electrode.

[0071]In this case, two inter electrode distances become equal also in which light-emitting part 20, and voltage can be prevented from changing with the light-emitting part 20. About electrode wiring, the n lateral electrode 44 can be easily wired by carrying out bonding soon. Therefore, what is necessary is just to wire a wiring board to the p lateral electrode 13.

[0072]Therefore, according to this embodiment, smaller laser besides the same effect as a 1st embodiment is obtained, and the effect that wiring can be done simply is acquired. This semiconductor laser can form the nitride semiconductor 35 by the method explained to a 2nd embodiment, and can also manufacture the layer produced by removing that lower layer portion with the crystal part 33A as the nitride semiconductor layer 45. In this case, if the nitride semiconductor layer 35 is separated from the substrate 31 in respect of including the crevice 31B, the substrate 31 can be removed comparatively easily. After forming to the light-emitting part 20 previously, it is also possible to manufacture substrate 1 (or substrate 31) side portion of the nitride semiconductor layer 5 (or nitride semiconductor layer 35) by the method of carrying out separation removal.

[0073]As mentioned above, although the embodiment was mentioned and this invention was explained, this invention is not limited to the above-mentioned embodiment, and is variously deformable. For example, although the light-emitting part 20 was made into a simple structure where the semiconductor layer of a p type and a n type was laminated by the upper and lower sides of the active layer 9, respectively, in the above-mentioned embodiment, this invention is applicable regardless of the structure of a light-emitting part. For example, make the upper part of p side contact layer and a p type clad layer into ridge structure with narrow width, or. It is good also as a structure which may consider it as the internal stripe geometry which provided the current stricture layer in the upper surface of the p type guide layer, and has not only profit waveguide mold structure such but refractive-index waveguide type structure or both sides.

[0074]The light-emitting part 20 of the semiconductor laser in each above-mentioned embodiment. It is an example of 1 composition of a light-emitting part, for example, is not necessary to have the guide layers 8 and 10, and may be made to have a buffer layer which consists of a near nitride system III-V fellows compound

crystal amorphously between the substrate 31 and the seed crystal section 33 in the semiconductor laser concerning a 2nd embodiment. Although laser was constituted by making the nitride semiconductor layer 35 into n side contact layer, it may be made to provide n side contact layer separately on the nitride semiconductor layer 35 in a 2nd embodiment.

[0075]In a 2nd embodiment of the above, after removing the insulator layer 34, the nitride semiconductor layer 35 was formed, but it may be made to form the nitride semiconductor layer 35, without removing the insulator layer 34 on the seed crystal section 33 (crystal part 33A). In that case, penetration dislocation D_1 is intercepted with the insulator layer 34, and propagation of penetration dislocation D_1 from the seed crystal layer 12 is prevented. Therefore, except for penetration dislocation D_2 resulting from a meeting, a crystal defect hardly exists in the nitride semiconductor layer 35, but it becomes possible to obtain the nitride system III-V fellows compound which has the crystallinity excellent in the upper part. However, as for a manufacturing method, since there is also a possibility of degrading the characteristic of a semiconductor laser when growing up the nitride semiconductor layer 35 and the component of the insulator layer 34 mixes as an impurity, choosing suitably is preferred.

[0076]Although each above-mentioned embodiment explained the case where a nitride system group III-V semiconducter was formed by the MOCVD method, the growing method of a semiconductor layer is arbitrary --- in addition, MBE (Molecular Beam Epitaxy; molecular beam epitaxy) -- law and MOVPE (Metal Organic Vapor Phase Epitaxy; organic metal vapor growth) -- law. HVPE (hydride vapor phase epitaxy) -- it can form with vapor phase growth, such as law.

[0077]Although begin the seed crystal layer 3 and the crystal part 33A, a contact layer and a guide layer are formed by GaN, a cladding layer is formed with an AlGaN mix crystal and the active layer was formed with the InGaN mix crystal in each above-mentioned embodiment, It may be made to form these layers by other nitride system groups III-V semiconducter containing at least one sort in group III elements, and nitrogen.

[0078]In addition, although the substrates 1 and 31 which consist of sapphire were used in 1st and 2nd embodiments of the above, the substrate of not only this but what kind of construction material may be used. For example, Si, SiC, GaN, GaAs, $MgAl_2O_3$, $LiGaO_2$, etc. can be used as a substrate. Among these, after making it grow up with hydride vapor phase growth or halide vapor phase growth on bases for growth, such as sapphire, a GaN board can be obtained by separating from the base for growth, and can be used as the nitride semiconductor layer 45 in a 3rd embodiment of the above.

[0079]

[Effect of the Invention]the low defect field which was formed based on the seed crystal section according to the semiconductor light emitting element of this invention as explained above, and alienation -- with the nitride semiconductor layer containing the meeting part formed in the field corresponding to a part. Since it had respectively two or more light-emitting parts which have a current injection region corresponding to the low defect field of a nitride semiconductor layer, the rearrangement and defect in each light-emitting part can decrease, and crystallinity can be raised. Therefore, the luminous efficiency of an element can be improved and a high increase in power can be attained.

[0080]Since the electrode of the 1st conduction type was provided in the upper part of the light-emitting part and the electrode and plane shape of said 1st conduction type carried out the light-emitting part as [identically] especially according to the semiconductor light emitting element according to claim 4, Two or more light-emitting parts can be obtained with sufficient accuracy at once by simple methods, such as etching which used the electrode of the 1st conduction type as the mask.

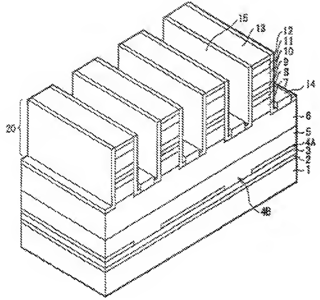
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a figure showing the composition of the semiconductor laser concerning a 1st embodiment of this invention.
[Drawing 2]It is the elements on larger scale of drawing 1.
[Drawing 3]It is a sectional view for explaining the manufacturing method of the semiconductor laser of drawing 1.
[Drawing 4]It is a sectional view for explaining the manufacturing process following drawing 3.
[Drawing 5]It is a sectional view for explaining the manufacturing process following drawing 4.
[Drawing 6]It is a sectional view for explaining the manufacturing process following drawing 5.
[Drawing 7]It is a sectional view for explaining the manufacturing process following drawing 6.
[Drawing 8]It is a figure showing the composition of the semiconductor laser concerning a 2nd embodiment of this invention.
[Drawing 9]It is the elements on larger scale of drawing 8.
[Drawing 10]It is a sectional view for explaining the manufacturing method of the semiconductor laser of drawing 8.
[Drawing 11]It is a sectional view for explaining the manufacturing process following drawing 10.
[Drawing 12]It is a sectional view for explaining the manufacturing process following drawing 11.
[Drawing 13]It is a sectional view for explaining the manufacturing process following drawing 12.
[Drawing 14]It is a sectional view for explaining the manufacturing process following drawing 13.
[Drawing 15]It is a sectional view for explaining the manufacturing process following drawing 14.
[Drawing 16]It is a figure showing the composition of the semiconductor laser concerning a 3rd embodiment of this invention.
[Drawing 17]It is a figure for explaining the electrode wiring of the conventional semiconductor laser.
[Description of Notations]
1, 31 [-- Growth deterrence layer,] -- A substrate, 2 -- A buffer layer, 3 -- A seed crystal layer, 4A 4B [-- Seed crystal section,] -- An opening, 31B -- A crevice, 33a -- The growth phase for seed crystal layers, 33 33A -- a crystal part and 33B -- alienation -- A part and 34 -- an insulator layer, and 5, 35 and 45 -- a nitride semiconductor layer, 6 [-- An active layer, 10 / -- The 2nd guide layer, 11 / -- A p type clad layer, 12 / -- p side contact layer, 13 / -- p lateral electrode, 14 44 / -- n lateral electrode, 15 / -- An insulating layer, D_1 D_2 / -- Penetration dislocation, M / -- Meeting part] -- n side contact layer, 7 -- A n type clad layer, 8 -- The 1st guide layer, 9

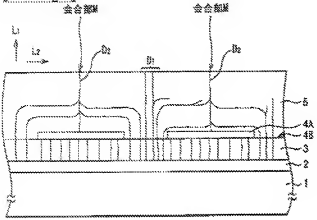
[Translation done.]

DRAWINGS

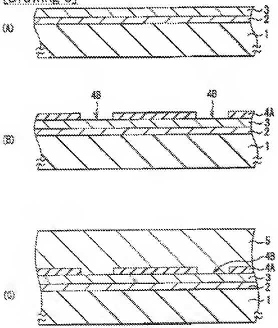
[Drawing 1]



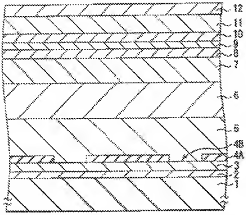
[Drawing 2]



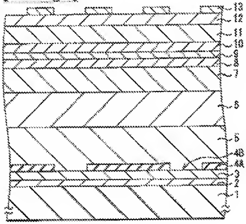
[Drawing 3]



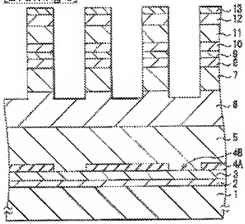
[Drawing 4]



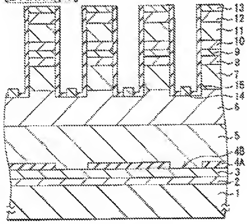
[Drawing 5]



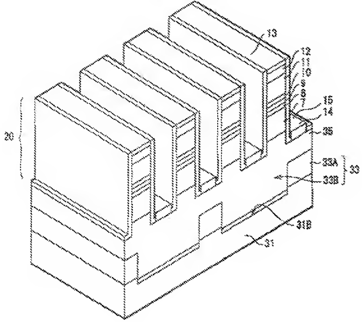
[Drawing 6]



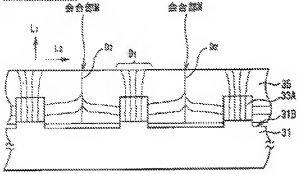
[Drawing 7]



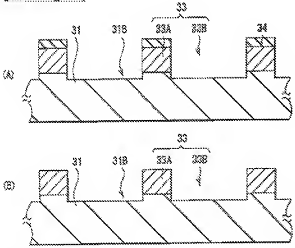
[Drawing 8]



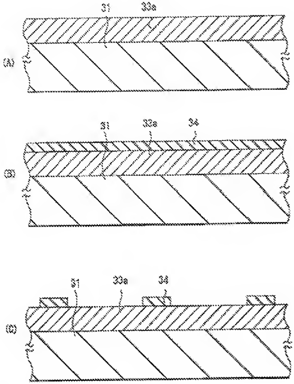
[Drawing 9]



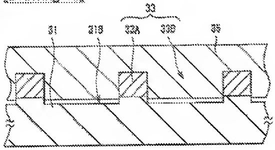
[Drawing 11]



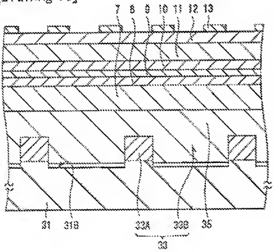
[Drawing 10]



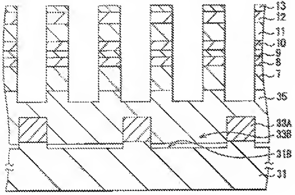
[Drawing 12]



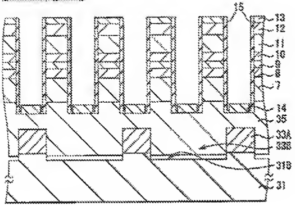
[Drawing 13]



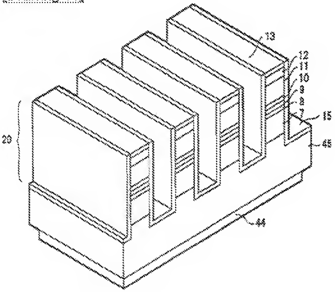
[Drawing 14]



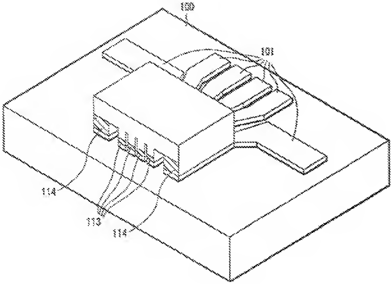
[Drawing 15]



[Drawing 16]



[Drawing 17]



[Translation done.]